E7.4-10.189
CR-136328

ERTS TYPE II REPORTS (JANUARY 3, 1974)

A. TITLE: Multispectral Signatures in Relation to Ground Control Signature Using Nested Sampling Approach.

B. PRINCIPAL INVESTIGATORS: R.J.P. LYON: F.R. HONEY
School of Earth Sciences
Stanford University
Stanford, California 94305
Phone: (415) 321-2300 ext 4147/2747

C. PROPOSAL #637; GSFC #UN 142; Contract # NAS 5-21884

D. TECHNICAL MONITOR: E.W. Crump
Code 430
Goddard Space Flight Center
Greenbelt, Maryland 20771
Phone: (301) 982-2857

E. PERIOD: November 4, 1973-January 3, 1974

Remote Sensing Laboratory
Stanford University
Stanford, California 94305

(E74-10189) MULTISPECTRAL SIGNATURES IN RELATION TO GROUND CONTROL SIGNATURE USING NESTED SAMPLING APPROACH Progress Report, 4 Nov. 1973 - 3 Jan. 1974 (Stanford Univ.) 24 p HC $3.25 CSCL 05B
N74-14053
Unclas
G3/13 00189

F. ABSTRACT

1. Principal effort has been on the development of a PDP-10 software package to read the CCT tapes more cheaply and rapidly. This is 90% completed and debugged. See shade print example over, for Treasure Island.

2. Stanford area was overflown with the U-2 as a add-on photographic mission on January 8 (ARC Flight 74-002) to help fill in record-gaps in ERTS overpass (clouded out).

G. PROBLEMS

1. Our request for a RBV tape for ERTS ID 1003-18175 was filled, but we received a MSS tape labelled as RBV (in the 2 heading lines directly on the taped data format):

a. The paper work indicated a RBV tape

b. The tape heading decoded as an RBV tape (lines 1-2)

but c. The data (lines 3-end) decoded as 4-channel MSS-type digital numbers.

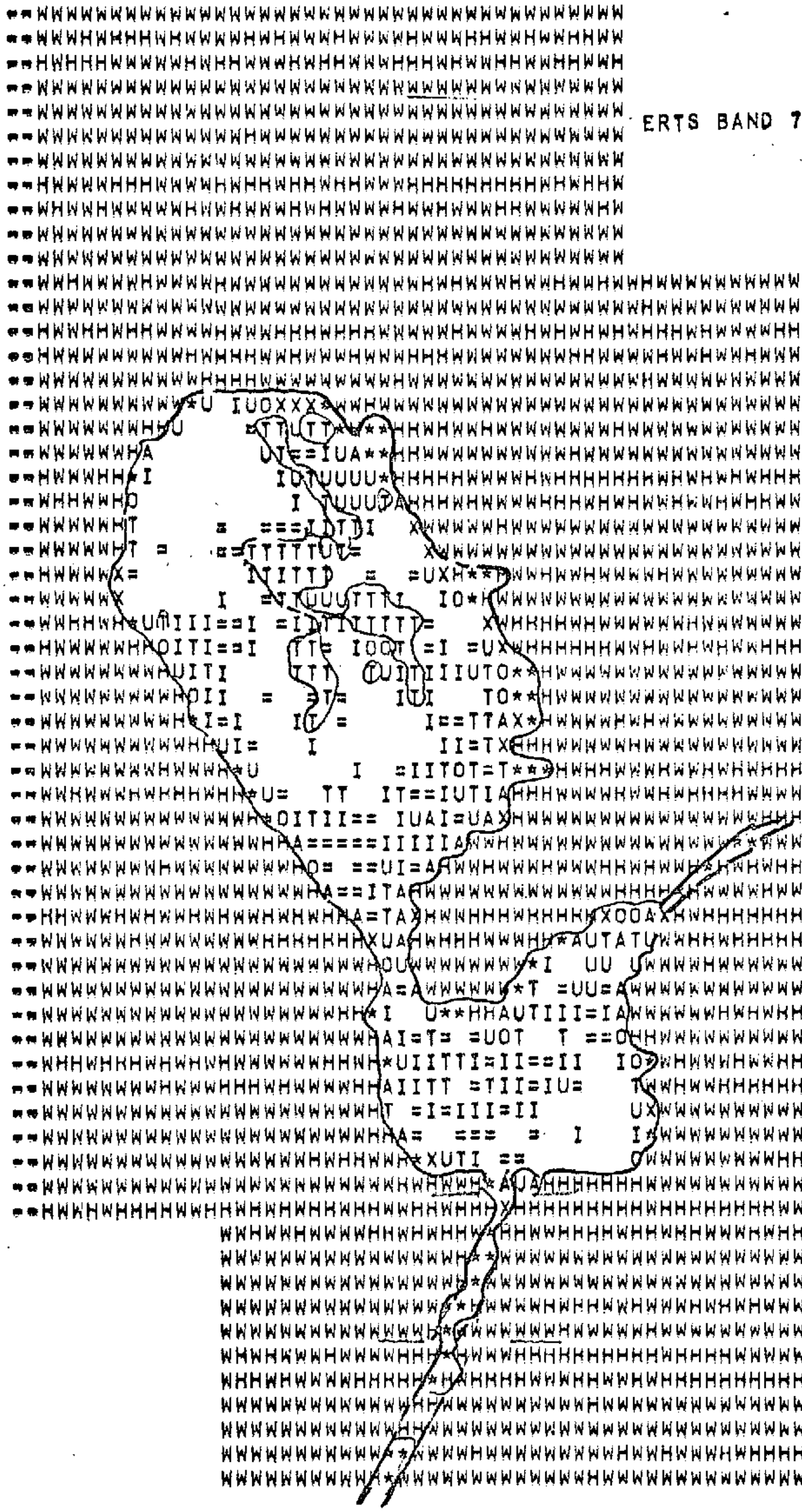
Action: We are telephoning direct to the NDPF to resolve the conflict.

2. Seven (7) tapes requested in Data Request Forms F & G have not yet been received.

	ERTS ID	Date Requested
Request F	1361-18060	November 5, 1973
Request G	1154-18175	November 5, 1973
Request G	1309-18181	November 5, 1973
Request G	~~1327-18180~~ (excessive noise) GSFC	November 5, 1973
Request J	1054-18001	November 12, 1973
Request J	1162-18004	November 12, 1973
Request J	1342-18003	November 12, 1973

These tapes are required as soon as possible.

SHADE PRINT OF AREA 1BEGINNING ATLINE 780,COLUMN (OR PIXEL) 901



ERTS BAND 7

STEP INTERVAL=2
W= 0-2
H=2-3
*=4-5
X=6-7
A=8-9
O=10-11
U=12-13
T=14-15
I=16-17
==18-19
 =REST

TREASURE ISLAND
1255-18183

IN=2
CH=7

BAY BRIDGE
→ OAKLAND

YERBA BUENA ISLAND

04APR73 C N37-31/W122-02 N N37-28/W121-54
190-3556- -1- D- NASA ERTS E-1255-18183-

SUN EL49 AZ134
D
G-6W122-30|E|N038-30

H. ACCOMPLISHMENTS DURING THE PERIOD (November 3-January 3, 1974)

1. Completed the Woodside serpentine study. (See section I for detailed descriptions).

2. Collected field data on sky irradiance and terrain reflectivity continuously while moving over a traverse of 2.5 miles length, for a 2-3 hour period around the time of ERTS overpass on,

a. November 24: #1489 overpass
b. December 12: #1507 overpass
c. December 30: #1525 overpass

3. Located an area of very low radiance, spectrally black, coke-byproduct from the Phillips Petroleum Refinery on the south shore of Suisan Bay on the Sacramento River, 65 miles north of Stanford (but on the same ERTS CCT tape). Data values derived from a 13-month period of tapes showed the following variability of ERTS spectra, for a 45-pixel area.

		MEAN	CARBON	SPECTRUM		
ERTS #	DATE	CH4	CH5	CH6	CH7	(UNCORRECTED DN)
1003	7/26/72	19.0	11.9	10.9	2.1	
1075	10/06/72	18.6	9.9	8.2	1.6	
1183	1/22/73	NO	DATA:	CLOUDED	OVER	
1255	4/04/73	18.8	10.8	9.4	2.1	
1273	4/22/73	20.3	11.7	10.9	2.7	
1291	5/10/73	21.5	12.9	10.3	2.3	
1399	8/26/73	21.2	12.8	10.8	2.5	
	$\overline{X}$	19.9	11.7	10.1	2.2	
	σ_x	1.27	1.16	1.09	.38	
	cov_x	(0.06)	(0.10)	(0.11)	(0.17)	

4. Located an area of very high radiance white salt, heaped in a storage area near Redwood City harbor. Between 2-5 pixels cover the small area, from which one very high radiance value pixel may be chosen, which usually saturates the system giving a digital number value of 127 on the tape (usually CH 5). Typical values are:

		HIGHEST SALT SPECTRUM			
ERTS #	DATE	CH4	CH5	CH6	CH7
1003	7/26/72	111	127	110	53
1075	10/06/72	127	127	125	50
1183	1/22/73	84	91	86	40
1255	4/04/73				
1273	4/22/73				
1291	5/10/73	119	127	110	51
1399	8/26/73	113	124	112	47

5. The runways of NASA/ARC Moffett Field are oriented approximately N25°W; the prevailing wind is from the north. Accordingly the US Navy P3 Orian aircraft which use these runways preferentially land from the south towards the north into this wind. A considerable blackening of the south end of the runways (from rubber off the tires of the aircraft) can be seen on the ERTS images, and confirmed from the CCT output.

Average DN values down the center line of the left runway

	CH 4	CH5	CH6	CH7
N end	22.0	16.4	16.1	6.1
Central	21.4	17.2	15.2	5.7
S end	20.4	15.4	13.4	5.1

6. Nearby each of these 3 areas occur bodies of water which have been similarly examined and their digital values averaged and compared over the 13-month period.

A. SUISAN BAY WATER, NEAR CARBON SITE

ERTS ID	DATE	CH4	CH5	CH6	CH7	(N)
1003	7/26/72	28.4	23.2	16.4	4.1	
1075	10/06/72	26.1	19.3	10.9	1.5	
1183	1/22/73	NOT	AVAILABLE	CLOUDED		
1255	4/04/73	29.5	24.2	11.8	1.7	
1273	4/2273	34.4	30.4	20.9	4.4	
1291	5/10/73	3 .9	28.6	15.6	3.3	
1399	8/26/73	30.9	24.7	15.4	3.1	(32)

Ratio CH4/CH5: 1.13-1.35

B. S.BAY WATER, NEAR REDWOOD CITY PORT

ERTS ID	DATE	CH4	CH5	CH6	CH7	(N)
1003	7/26/72					
1075	10/06/72	22.3	12.3	5.9	1.0	(47)
1183	1/22/73					
1255	4/04/73					
1273	4/22/73					
1291	5/10/73	25.6	15.1	9.1	0.9	(24)
1399	8/26/73	29.6	19.0	9.3	1.2	(32)

Ratio CH4/CH5: 1.56-1.81

Thus the S.Bay water consistently shows a lower radiance than the main body of Sacramento River water at Suisan Bay. As one criterion of this the CH4/CH5 ratio is much lower for the Sacramento Bay water at each of the seven times sampled over the 13-month period.

These values contrast markedly with the waters of Mono Lake 200 miles to the east, where our studies show typical deep and shallow lake water to have the following average spectrum.

MONO LAKE WATER

	ERTS ID	DATE	CH4	CH5	CH6	CH7	(N)
Deep.	1091-18062	10/22/72	15.8	6.8	2.9	0.2	(50)
Shallow	1091-18062	10/22/72	20.92	12.40	6.22	0.74	(50)

With CH4/CH5 ratios of 2.32 (deep) and 1.69(shallow) respectively.

6. Analysis of Mono Lake ERTS Data

Research on Mono Lake ERTS data has been conducted in the areas of spatial and spectral analysis, with future research in changes from one overpass to another to be attempted.

a. Spatial Analysis:

The ERTS pixel spacing, orientation and location relative to a base map was calculated by use of the gray scale print out of band 5, a 1:31,680-scale rectified photomap and a computer program (ERTSMAP) which assumes that for small areas (15-minute quadrangles) that the ERTS scan lines and the columns which individual pixels form are parallel and equally spaced relative to each other.

In this method points which can be recognized on the photomap (small lakes, road intersections, stream junctions, small craters, etc.) are plotted to the nearest 0.5 scan line and 0.5 pixel column on the pixel shade print. The program then uses the control points to find the relationship between the geographic and ERTS pixel coordinates.

Preliminary results indicate that the average pixel spacing is 78.6 meters between scan lines and 57.8 meters between columns in the vicinity of Mono Lake (based on 8 control points).

b. Spectral Analysis:

Studies of digital tape data from the 22 October 1973 ERTS overpass of Mono Lake have been made to determine suitable areas for reflectance calibration and to determine the variability of terrain reflectance spectra.

A total of ten reflectance test sites were selected from an area centered on the islands in Mono Lake. Histograms showing the variability of ERTS digital numbers in each band were obtained for each of the 50-to 100-pixel sample sites. The areas selected for study represented a wide range of reflectances and were intended to establish a "grayscale" of brightness.

Five areas of water show a gradual decrease in reflectance with increasing depth, with channel 7 digital number values of 0 or 1 occurring in the "deep" water of the lake. A basalt flow on the north shore of Negit Island shows low brightness values which are so similar to those of shallow water in every ERTS channel that the shallow water/basalt contact cannot be determined by simple inspection of the digital numbers.

Areas of volcanic ash, diatomaceous earth, beach deposits and calcareous tufa show an increase in reflectance, with one large area on the west side of Paoha Island showing digital numbers in excess of 70 in channel 4 and in excess of 25 in channel 7. This is probably an area of beach deposits composed of calcareous tufa (calcium carbonate) and would make an excellent high-reflectance reference. This combined with the medium reflectance of volcanic ash and the low reflectance of basalt and deep lake water make the Mono Lake islands an excellent reflectance calibration area.

c. Spectral Pattern Recognition:

The difficulty of distinguishing basalt from adjacent shallow lake water poses a potential problem in the area of water body mapping using a single ERTS infrared channel. In order to see if two channels would give better discrimination, each of the six possible combinations of channels were plotted against each other. The resulting scattergrams showed that the water had little spectral variability and tended to form tightly grouped circular clusters, while the basalt showed a greater variability and formed more loosely grouped enlongate clusters. This suggested that two channels considered simultaneously would provide a better method of distinguishing water areas from spectrally similar land areas.

A terrain mapping computer program based on the principle of fourth dimensional spectral classification (ERTS4D) has been written and preliminary results indicate that it can map water areas without confusing them with basalt flows.

d. Comparison of ERTS and Field Spectra:

The differences between the relative spectral response of the ERTS MSS and the ground radiometer are large enough to suggest that methods of comparing detector-filter combinations in the two systems must be used. Both traditional and newly derived methods of finding the center wavelength (center lambda) and effective band width (delta lambda) were used to compare MSS and ground radiometric data. The concepts of using the center of moments about the spectral response curve to compute the center wavelength and of using the total area under the response curve to calculate the effective band width were introduced and the program ERTSFILT written to calculate these values for both the MSS and the ground radiometer.

e. Laboratory Calibration of EGTR:

In order to determine the variability of spectra obtained by the Exotech ERTS ground truth radiometer, a calibrated light source was observed at regular intervals between field use. In this way variations caused by battery condition or electronic component aging can be corrected when data taken at widely differing times (e.g., from year-to-year) are to be compared. Other variations noted include that of voltage offset (dark voltage) and are used in the program ERTSRATS to apply corrections which are used to find the zero radiance or irradiance value of field data.

ERTSRATS is also used to calculate the "absolute" bandpass irradiance of the laboratory light source. These values are to be compared with the values expected from observing the light source and suitable correction factors are to be derived. This process will be used to improve upon the original voltage-to-irradiance values supplied by the EGTR manufacturer.

f. Analysis of Field Data:

Field radiometer data of the North Craters sand flat and the south shore of Mono Lake were obtained on 30 June and 1 July 1973. In addition to using the program ERTSRATS to compute absolute bandpass radiance and irradiance values, the values were plotted against time of day and the resulting curves analyzed. Results thus far indicate a general increase until local solar noon is reached and a general decrease after it is passed. A program to compute solar elevation and azimuth angles from ephemeris data has been wirtten (SUNANGLE) and will be used to see if incident and reflected solar radiation varies as the sine of the solar elevation angle. Another variation is that of spectral shape with sun elevation and should be determined before ratios of one channel relative to another are computed.

I. SIGNIFICANT RESULTS:

SPECTRAL CHARACTERISATION OF TERRAIN TYPES

A. Study of Serpentine Outcrop areas along Highway I-280, Stanford Site.

1. Objective:

To study the serpentine rock exposures on the San Francisco Peninsula following the general procedures outlined in the ERTS Type II Report dated 3 November 1973.

2. Procedure and Results:

a. Visual Study- Three major exposures of serpentine rocks have been mapped by the U.S.G.S., on the San Francisco Peninsula and are shown in Figure 1. A visual study of available ERTS imagery, both the four individual spectral bands and the band 5 and 7 color composites was accomplished. This study also included U-2 imagery taken during the ERTS Simulation Program and other test flights. Results are outlined below:

(i). In ERTS frame 1075-18173 band 7, dated 6 October 1972, a distinct pattern was noted which seemed to coincide generally with the serpentine exposure east of Crystal Springs Reservoir (see Area I, Figure 1). This pattern was seen to exist with diminishing clarity on all ERTS band 7 images back to 26 July 1972, at which time it was barely discernible. Study of the subsequent ERTS images revealed no pattern until 26 August 1973, at which time it was again faintly discernible. The appearance and disappearance of the observed pattern seems to correlate with the die-back and growth cycle of the grass in this area during the dry and rainy seasons.

(ii). Review of the color composites of bands 5 and 7 substantiated the above, with the pattern readily discernible at the dates noted as a dark purplish gray tone, the intensity coinciding with the intensity of the band 7 frames. In addition, light blue gray tones are discernible at the Interstate 280 and Route 92 interchange (Area II, Figure 1), and at the bend just south of the Farm Hill Rd. exit on I280 (Area III, Figure 1). The pattern at Farm Hill Rd. is extended somewhat to the northeast by a dark purple tone. Both of these locations fall within the serpentine exposures shown in Figure 1. A dark purplish gray pattern (Area IV, Figure 1) somewhat between the tones of Area I and Area II is also discernible on Jasper Ridge just south of the Stanford Linear Accelerator Center. This pattern is apparently on Jasper Ridge which also contains a substantial exposure of serpentine.

A field check of the areas noted was made on 31 October 1973 and showed Area I to consist largely of highly weathered blue-gray serpentine outcrops and soil with sparse cover of dried grass (6 to 12 inches high). About 20% of the area was covered with stunted oak and chaparral. Area II and the south end of Area III are freshly cut or filled construction areas, of fragmented blue-gray and purple serpentine, adjacent to Interstate 280 and Route 92 and large bare road cuts related to I280. Area IV on Jasper Ridge consists of disintegrating serpentine exposures and serpentine soil with larger boulders and small outcrops evident toward the north end of the ridge. The vegetation cover is a dried grass 6 to 12 inches high with a small percentage of stunted oaks. The outcrops and large boulders are covered with a high percentage of yellow, orange, green and gray lichen. Rock samples and photographs of typical exposures in these areas were taken.

(iii). In Area III, the serpentine road cuts were indicated as blue gray tones in the NASA/ARC U-2 imagery flown with the HR 732 camera and color IR film on 22 November 1972. The outcrops and large boulders of serpentine in the north end of Area IV were also evident in blue gray tones while the rest of the area was a mottled green and red tone. No U-2 color IR coverage with good color balance was available for Areas I and II.

b. <u>ERTS Spectral Study</u>. In order to study the possible uniqueness of the tones associated with the serpentine areas noted, the radiance values of ERTS CCT pixels traversing these areas are being obtained and their spectra plotted. The first of the pixel traverses A-A, B-B, C-C, D-D, E-E and F-F are indicated in Figure 2, a shade print of the vicinity of Crystal Springs containing Areas I and II above.

Table I shows these traverses and their pixel spectra with mean and 1σ values as calculated. Figure 3 contains typical radiance spectra plots by pixel. The location of specific features was accomplished by means of a pixel overlay of the proper scale and an ortho-photomap (1:24,000), as well as aerial photographs of the area.

It can be seen from examination of the spectra plots that the serpentine areas as well as I280, water and the forested areas appear to have distinctive spectra. It is interesting to note that while the pixel spectra across the forested area in traverse BB are generally the same shape, peak values are evident at four points. The aerial photos indicate that these coincide with hilly terrain across which the traverse was made. Conceivably the trees thin out at one side of the hill slope or the sun angle effect is apparent.

The consistency of the water spectra is also very striking. In traverse DD, the consistency of the pixel spectra of the serpentine area on the east side of I280 as contrasted to the west can be correlated to the tones evident in the ERTS imagery. The slight variability evident on the west side can possibly be explained by the inconsistency in grass cover. At this point it is difficult to be sure that the specific spectrum plotted is that of the serpentine or of the thin dry grass cover or an interaction of both.

3. <u>Intended Activity Next Period</u>:

Continued study of serpentine Areas II, III and IV and correlation with results obtained on Area I. Subsequent study will investigate the relationship of the seasonal aspects noted, to the unique discrimination of the serpentine areas. Hopefully, further correlative studies will then be made with the Coast Range and Sierra Nevada foothills serpentines. It is intended that a computer program be utilized to expedite the study of the pixel radiance spectra.

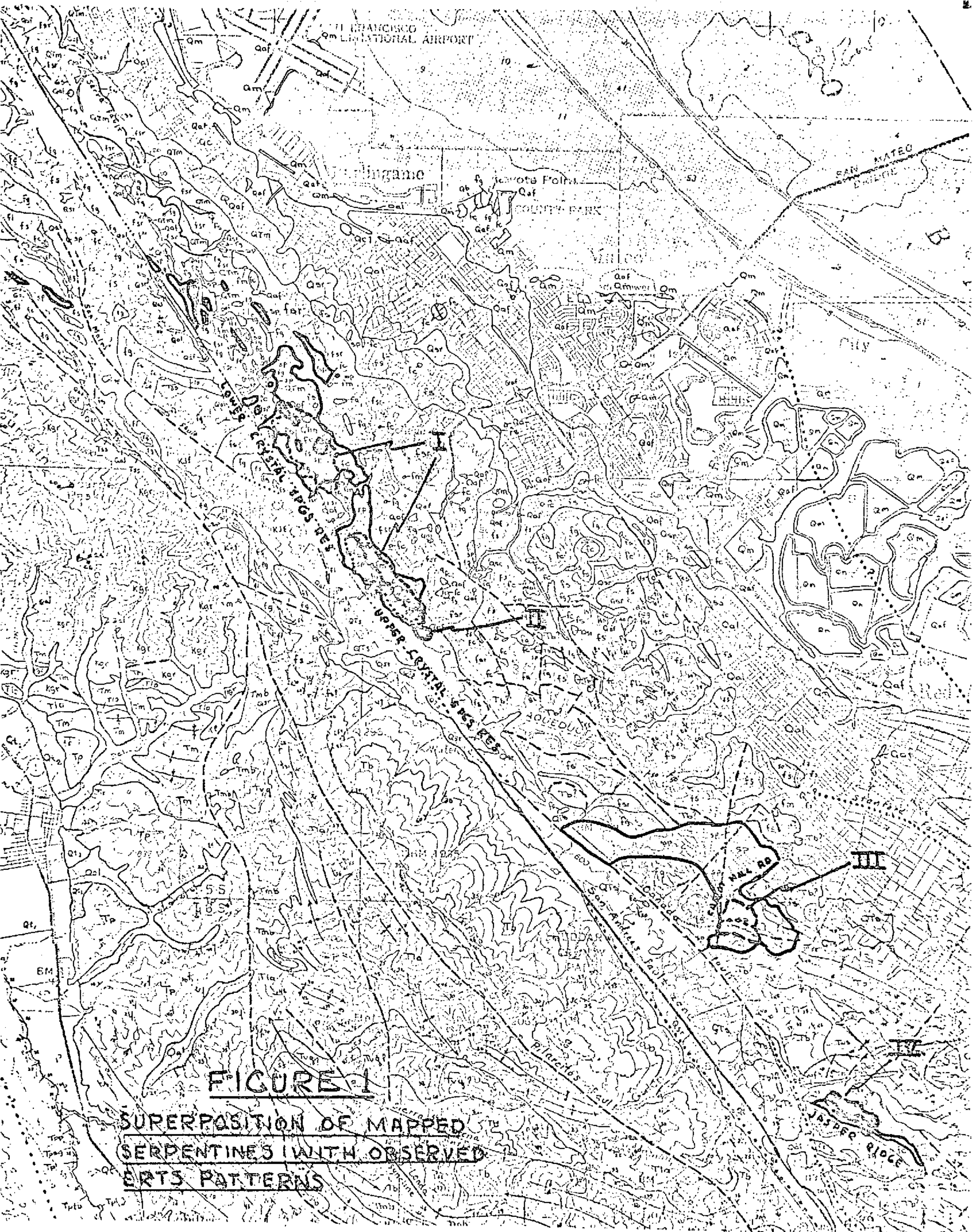


FIGURE 1

SUPERPOSITION OF MAPPED SERPENTINES WITH OBSERVED ERTS PATTERNS

SHADE PRINT OF ERTS FRAME 1075-18173 BAND 7
ORIGIN OF THIS STRIP AT 600 1170 IN=18 ADD '2' TO LINE NUMBERS

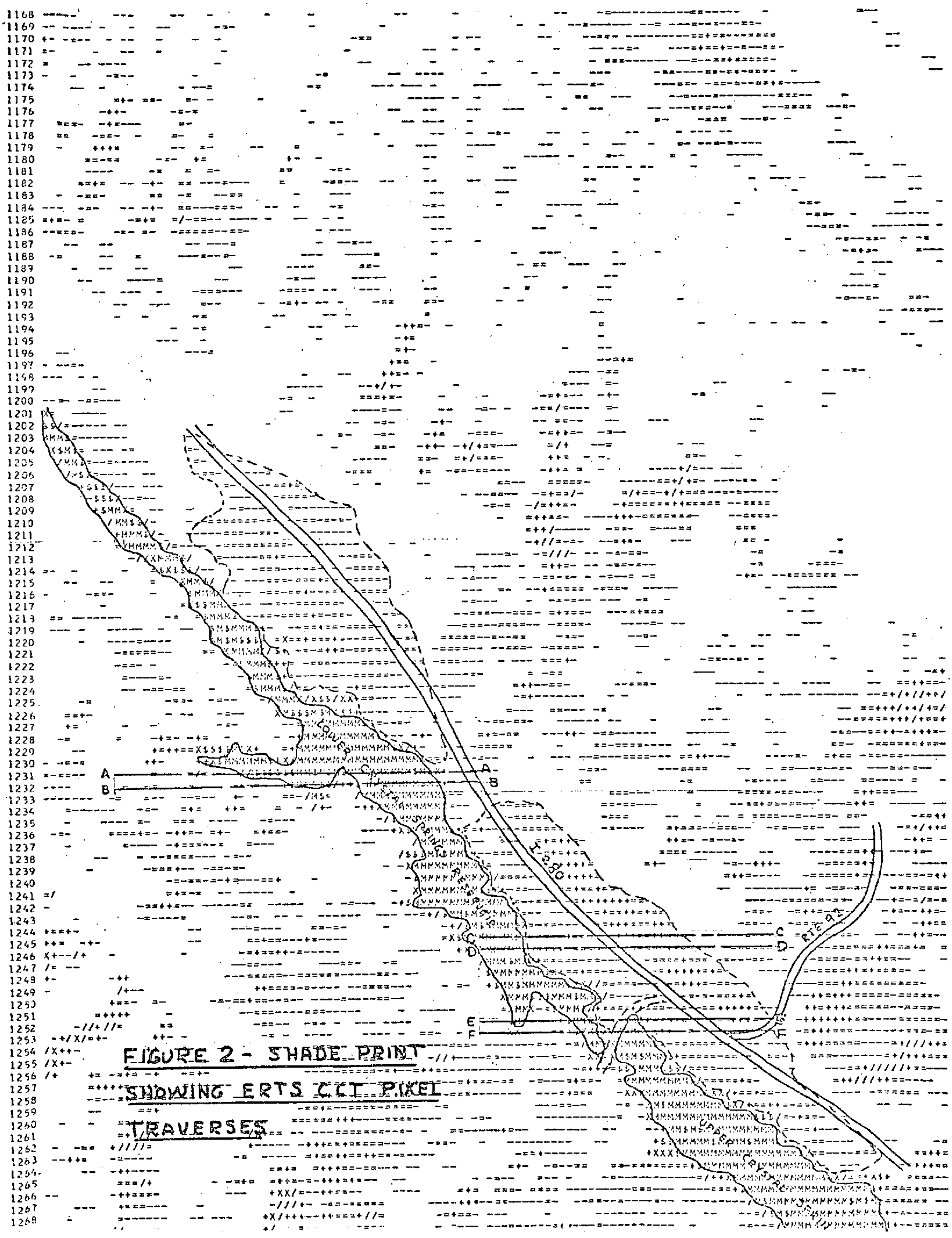
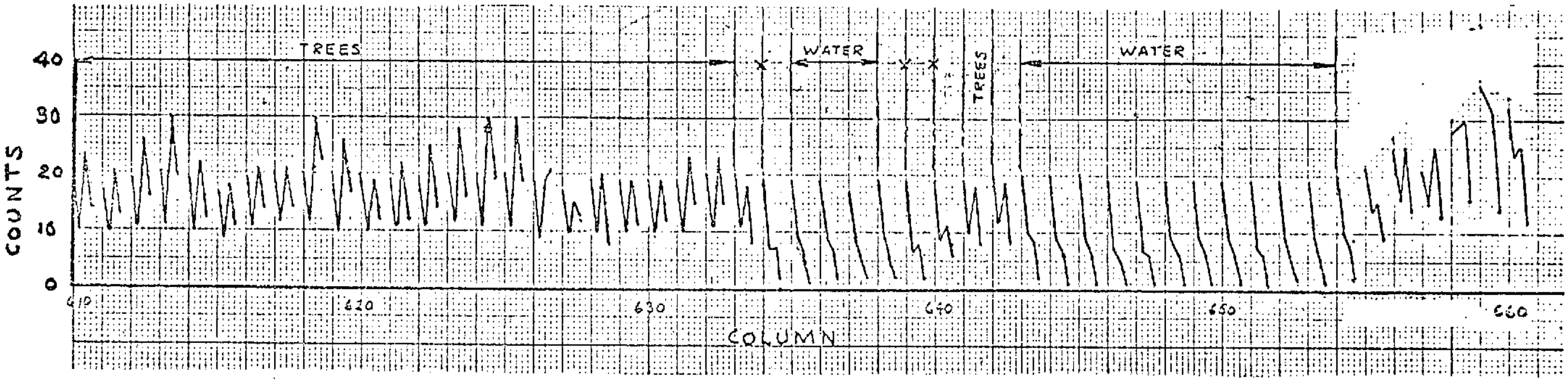
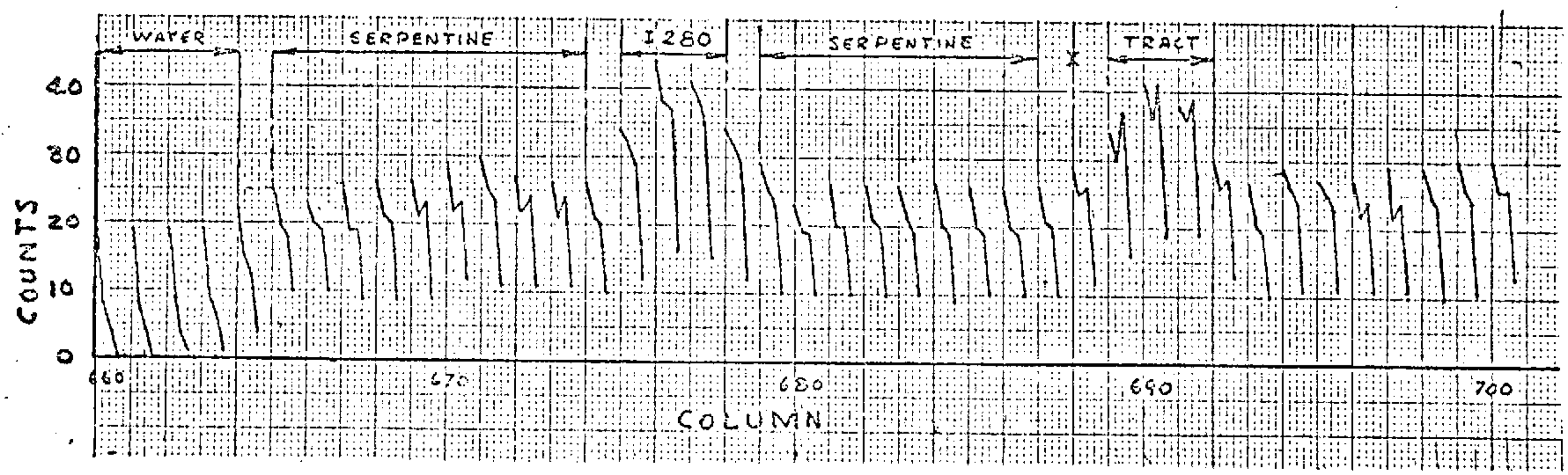


FIGURE 2 - SHADE PRINT SHOWING ERTS CCT PIXEL TRAVERSES



LINE 1234 (TRAVERSE BB)



LINE 1248 (TRAVERSE DD)

FIGURE 3 - TYPICAL RADIANCE SPECTRA BY PIXEL

TABLE 1
Statistics Plotted from Selected
ERTS Pixel Traverses AA to FF

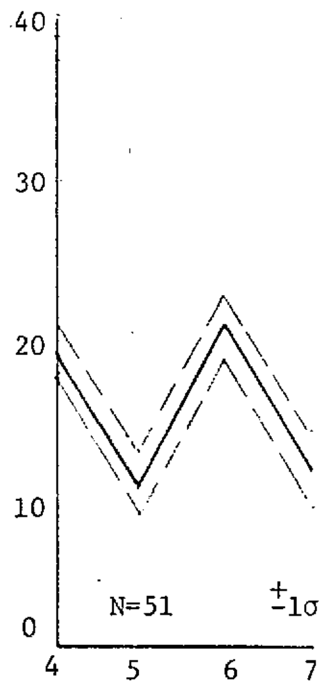
TREES

4	5	6	7
18	10	23	13
18	9	21	13
18	10	24	14
17	9	18	10
20	11	21	12
21	13	23	13
18	10	20	11
17	9	13	7
18	9	18	11
18	10	23	14
18	10	21	13
20	10	26	16
20	11	26	15
18	9	15	7
18	9	13	6
17	10	23	13
17	10	20	16
19	11	26	16
19	10	22	13
17	9	18	11
19	11	22	14
20	12	22	14
19	10	26	17
19	10	19	12
19	11	22	14
19	11	25	16
19	9	19	13
17	10	15	8
19	10	20	12
19	10	19	11
19	9	19	12
19	10	23	15
20	11	23	15
20	11	18	8
19	10	17	8
22	14	26	15
20	13	23	13
20	11	23	14
20	13	26	15
22	15	17	8
22	15	25	14
22	16	20	12
20	12	20	13
20	14	23	13
21	16	22	13
22	16	23	14
22	16	20	11
21	12	19	11
21	12	19	10

	4	5	6	7
Mean	19.33	11.20	20.88	12.25
Std. Devs.	1.48	2.09	3.42	2.72
Coef. of Var.	0.08	0.19	0.16	0.22

Number of Pixels-51

TREES (Traverses AA,BB,EE,FF) ID 1075-18173
6 October 1972



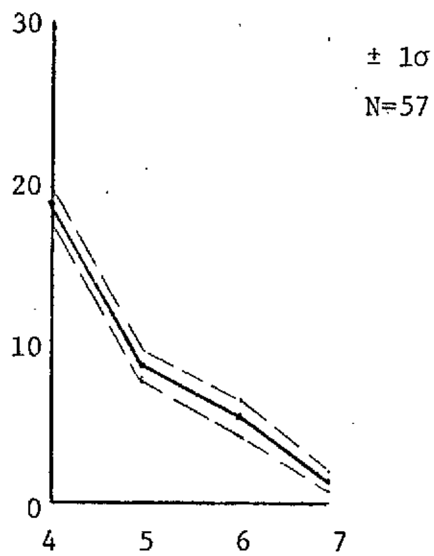
WATER

4	5	6	7
18	10	7	2
18	9	7	2
18	9	6	2
20	10	6	2
18	7	5	2
18	7	5	2
18	9	7	1
20	9	5	2
18	9	6	1
18	9	6	2
18	9	6	1
18	9	6	2
20	9	6	1
20	9	5	1
20	9	5	1
20	10	5	1
20	9	6	1
18	9	5	1
18	9	6	1
20	9	6	1
20	9	5	2
20	9	5	1
18	9	5	2
19	10	8	2
19	9	7	2
17	9	5	2
19	9	6	2
20	10	8	2
20	9	6	1
20	9	6	1
19	7	5	1
19	7	6	1
19	9	6	1
19	9	6	1
19	9	6	1
19	7	6	1
19	9	5	2
19	9	6	1
20	10	8	2
20	8	6	1
18	8	6	1
18	9	6	0
19	8	4	0
19	9	4	1
19	9	6	1
19	8	5	1
19	9	4	1
20	9	4	1
20	10	7	2
20	8	5	1
20	9	5	1
20	9	5	2
21	9	5	0
20	8	3	1
20	9	5	1
20	11	7	2

	4	5	6	7
Mean	19.14	8.89	5.67	1.32
Std. Dev.	0.90	0.82	1.01	0.57
Coef. of Var.	0.05	0.09	0.18	0.43

Number of ~~Pixels~~=57

WATER (Traverses AA,BB,CC,DD,EE,FF) ID 1075-18173
6 October 1972



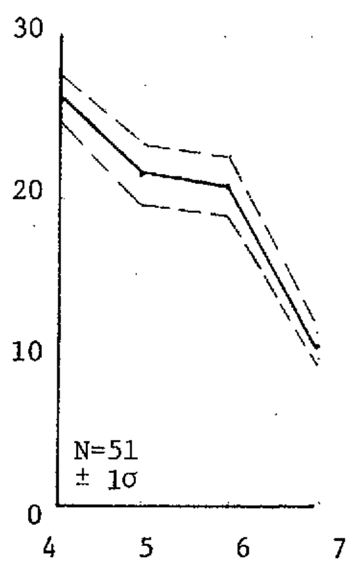
SERPENTINE

4	5	6	7
25	20	19	10
26	20	21	11
25	20	21	11
26	21	21	10
27	22	24	11
27	23	22	9
27	23	22	10
27	26	24	10
25	22	19	9
26	21	19	9
25	20	19	10
25	20	21	11
26	21	19	9
25	20	19	9
26	21	21	10
26	21	22	11
26	23	24	11
26	20	18	10
23	20	19	10
26	19	19	9
26	21	20	9
26	21	23	9
29	22	23	12
29	25	23	11
27	22	24	11
26	21	24	11
29	25	23	10
23	19	19	10
26	20	20	10
26	21	20	10
26	21	19	10
26	20	19	9
26	20	19	10
26	20	19	10
26	21	20	10
29	25	26	12
26	20	19	10
27	22	20	11
29	22	20	10
26	21	18	9
29	22	23	11
27	25	24	12
27	22	23	11
26	21	23	10
30	26	24	11
30	27	23	10
27	22	19	10
27	21	18	9
26	21	19	9
26	21	19	9

	4	5	6	7
Mean	26.53	21.67	20.88	10.12
Std. Dev.	1.51	1.93	2.13	0.86
Coef. of Var.	0.06	0.09	0.10	0.08

Number of Pixels-51

SERPENTINE (Traverses CC,DD) ID 1075-18183
6 October 1973



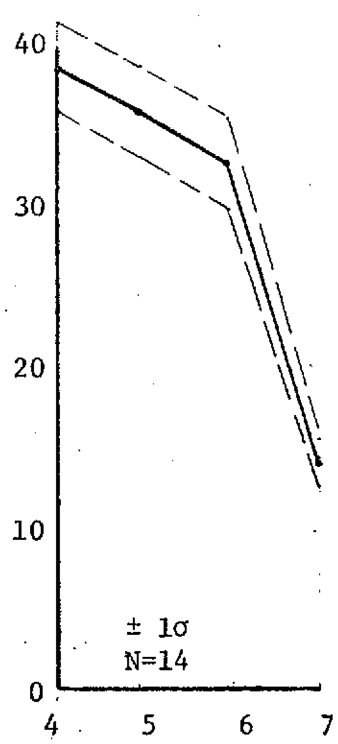
I280

4	5	6	7
38	36	31	14
42	41	37	16
38	33	29	12
34	32	29	12
44	38	37	11
41	38	35	15
37	33	31	14
41	26	35	15
38	38	32	15
37	36	29	13
34	32	28	12
39	38	31	15
43	40	25	15
38	35	31	14

	4	5	6	7
Mean	38.86	36.14	32.4	13.79
Std. Dev.	3.03	2.88	3.08	1.53
Coef. of Var.	0.08	0.08	0.10	0.11

Number of Pixels-14

I-280 (Traverses CC,DD,EE,FF) ID 1075-18183
6 October 1973



J. NEXT PERIOD

Work is proceeding along the following lines.

1. A new, fully interactive CCT tape reading program is being debugged for use on the Stanford PDP-10 unit. This much lower cost operation will facilitate rapid tape access with shade printing and numerical output, for use by any relatively untrained investigator.

2. Field taped data are now converted into concurrent radiance (15°FOV) and downwelling 2π irradiance, facilitating calculation of directional reflectance for any 1 second period within our 2-3 hour mobile recording sessions during ERTS overpasses. CIE-type "color" coordinates are calculated for each group radiance and irradiance values, using channels 4, 5 and 7 of the 2 Exotech Ground Truth Radiometers.

3. These CIE type coordinates are extremely sensitive to "growth /vigor" of the grass. Conversion of the ERTS CCT data is being investigated for routine output as a single parametric measure of all 3 channels. Several other classification methods both supervised and unsupervised, are being investigated.

4. Data from ERTS overpasses and the concurrent field collection program are being correlated specifically to note the effect of the higher spatial resolution available in the ground data. A die-back data of May 14 $\pm$ 10 has been noted, at Stanford in 1973 data (ERTS) and a similar, soil-type related, growth pattern seen in ERTS frames for November 24, 1973.

5. A 24-month rainfall chart has been prepared for the 9 stations which cover the 25 square miles surrounding the open grass lands at Stanford. In general 1971/72 winter was a very dry one, while 1972/73 and 1973/73 (so far) have been excessively wet.

LOCAL TOTAL RAINFALL

WINTER SEASON	NORTH (Woodside)	WEST (Portola Valley)	SOUTH (Los Altos)	EAST (Palo Alto)
1971/72	15.8	15.5	8.7	6.9
1972/73	39.4	39.9	35.3	26.3
1973/74 (to date)	17.8	16.7	10.7	11.9

PALO ALTO 63 Year Average: 14.2

See attached Table I for Portola Valley and Palo Alto data since 1/1/71.

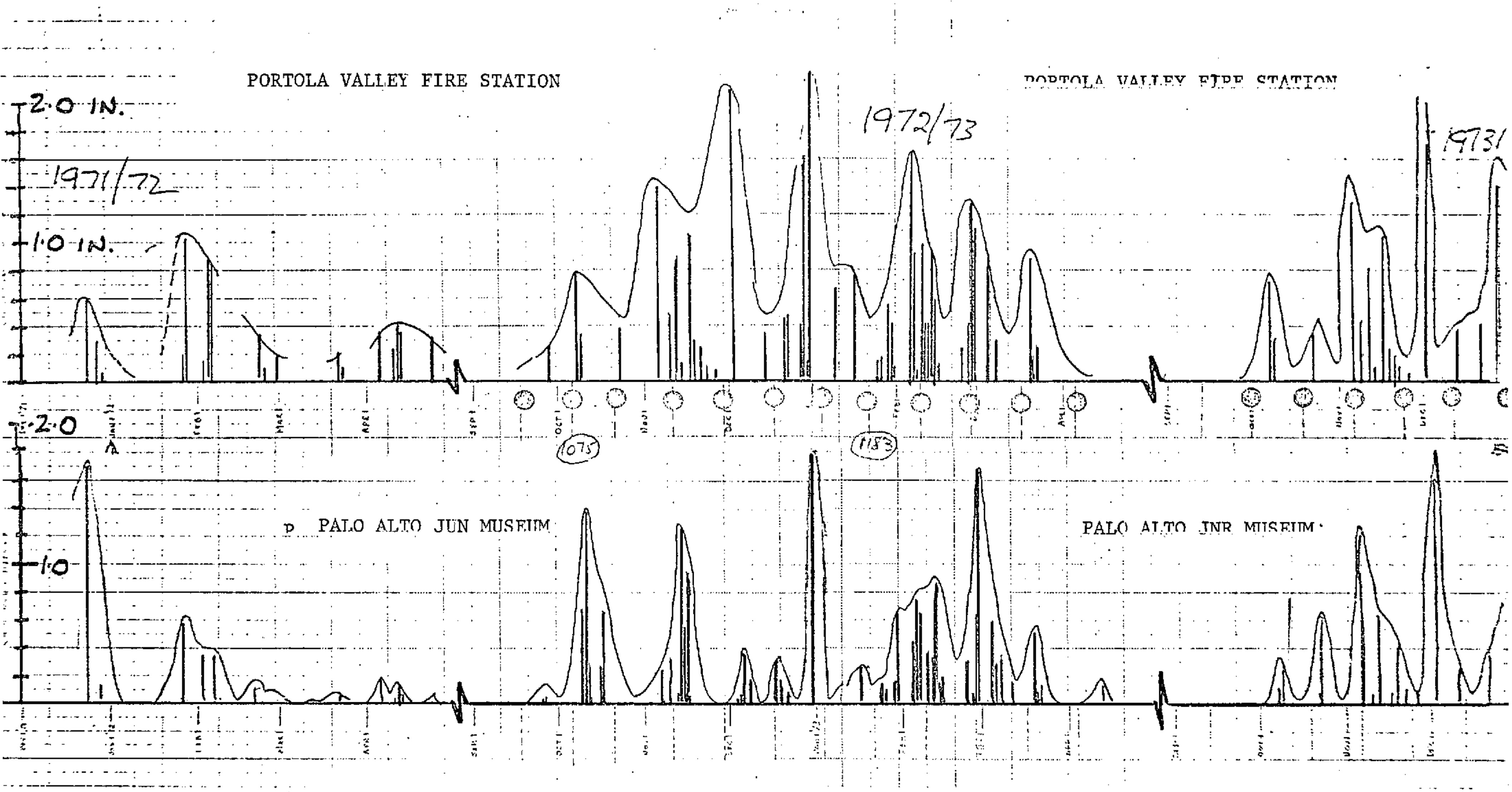


TABLE I TOTAL RAINFALL, BY DAY, FOR THE WET SEASONS 1971/72, 1972/73, and 1973/74(to date)

Vertical scale is in inches, divisions in 0.2 units; horizontal scale is in days, circles are ERTS overpass dates.

K. PUBLISHED MATERIALS

The following abstract has been submitted to the Committee for the Ninth International Symposium in Remote Sensing of Environment, to be held in April 1974. No decision has been forwarded to us yet:

"STANSORT-A SIMPLIFIED, LOW COST PATTERN RECOGNITION TECHNIQUE FOR ERTS SPECTRAL SIGNATURES."

by F.R. Honey and R.J.P. Lyon

ERTS spectra consist of four digital numbers (DN) relateable to absolute radiance from the terrain elements (pixels). The problem in data processing is that each quartet of images (one frame) consist of roughly 3×10^7 pixels. Accordingly any realistic data processing of the signatures must use a single algorithm in the computer to be cost effective.

The method consists of two steps (a) hand plotting step and (b) the computer algorithm STANSORT which uses only addition and subtraction logic to allocate spectra into classes, which were previously defined by hand plotting the average spectra from the control areas. The initial hand plotting stage itself is a very useful visual method of finding changes in terrain by the shape of the 4-element plots. Without such a graphical method, it is very difficult to recognize changes in 4-variable data, but changes in the relative gradiants between channels make pixel-by-pixel comparisons very diagnostic. STANSORT materially speeds these visual decisions by performing pattern recognition in computer algorithms.

Seasonal changes in spectra of constant reflectance ground targets obtained from successive ERTS overpasses were used to correct the basic digital numbers (DN) values for pixels, so as to allow for changes in aerosol and other atmospheric scatterings.

In the paper examples of classification of grassland are given, using ERTS signatures, over a full yearly cycle of growth (and death) for a two square mile control site. Effects of soil moisture and soil type on grass vigor and ERTS signatures are given in the processed digital printouts.

L. RECOMMENDATIONS

None

M. CHANGES IN STANDING ORDER FORMS

None

N. DATA REQUEST FORMS SUBMITTED

See attached, over.

O. ACCESSION LIST FOR ERTS IMAGERY/TAPES OVER STANFORD

1. Imagery, in-House (see over)
2. Tapes, in-House (see over)

P. MAILING LIST

At end of report.

TABLE 01. ERTS IMAGES ACQUIRED OVER STANFORD UNIVERSITY TEST AREA

	OBSERVATION ID	FIELD DATA	MICROFILM ROLL NO.	DATE ACQUIRED	CLOUD COVER	ORBIT NUMBER	PRINCIPAL POINT (C) OF IMAGE LAT.	LONG.	SUN AZIM	SUN ELEV	(R=REQUESTED) PRODUCTS RECD. AT STANFORD M	S	B7	P	M9
1.	1003-18175	-	10001/0126/7	07/26/72	10	42	3805N	12146W	118.7	58.7	4	4	-	2	R
2.	1021-18172	-	10001/1226	08/13/72	0	293	3724N	12145W	124.5	55.8	R	8	R	R	-
3.	1039-18172	-	10002/0074	08/31/72	0	544	3725N	12150W	132.5	51.9	4	2	R	R	-
4.	1057-18172	-	10002/0598	09/18/72	20	795	3721N	12149W	140.2	47.1	R	R	R	R	-
5.	1075-18173	-	10004/0236	10/06/72	0	1046	3729N	12144W	146.8	41.6	4	8	R	2	4
6.	1093-NO FRAMES TAKEN			10/21/72	-	1297			152.	35.	-	-	-	-	-
7.	1111-18181	-	10004/1570	11/11/72	60	1548	3715N	12153W	153.9	30.9	4	8	-	2	-
8.	1129-18181	-	10005/0498	11/29/72	20	1799	3725N	12150W	154.6	26.7	4	8	-	2	-
9.	1147-18181	-	10006/0333	12/17/72	90	2050	3718N	12151W	153.4	24.5	-	-	-	-	-
10,	1154-18175	-	10006/0898	01/04/73	10	2301	3724N	12146W	151.1	24.2	4	8	-	2	R
11.	1183-18175	-	10007/0170	01/22/73	20	2552	3732N	12146W	148.2	26.3	4	8	R	2	4
12.	1201-18181	-	10007/0782	02/09/73	80	2803	3725N	12151W	144.9	30.5	-	-	-	-	-
13.	1219-18182	-	10008/0440	02/27/73	100	3054	3726N	12156W	141.6	36.3	-	-	-	-	-
14.	1237-18183	-	10009/0470	03/17/73	40	3305	3727N	12200W	138.1	42.8	4	8	-	2	-
15.	1255-18183	-	10009/1329	04/04/73	0	3556	3730N	12201W	134.2	49.4	8	4	-	1	4
16.	1273-18183	-	10010/0613	04/22/73	0	3807	3726N	12201W	129.4	55.2	4	8	-	2	4
17.	1291-18182	F	10010/1539	05/10/73	0	4058	3731N	12201W	123.3	59.6	8	4	-	1	4
18.	1309-18181	F		05/28/73			3735N	12201W	117.0	61.0	8	4	-	2	R
19.	1327-18180	F		06/15/73			3730N	12153W	113.0	62.0	4	8	-	2	R
20.	1345-18174	F	10012/1181	07/03/73	30	4811	3725N	12202W	112.5	61.6	4	8	-	2	R
21.	1363-18173	F	10013/0135	07/21/73	30	5062	3725N	12202W	115.0	59.0	4	8	-	2	R
22.	1381-18172	R	10013/1276	08/08/73	50	5313	3721N	12203W	122.0	56.0	-	-	-	-	-
23.	1399-18170	R		08/26/73		5564	3726N	12201W	129.0	52.0	-	8	-	2	4
24.	1417-18164	-		09/13/73			3725N	12158W	137.9	48.0	4	8	-	2	-
25.	1435	-		10/01/73							-	-	-	-	-
26.	1453	F		10/19/73							-	-	-	-	-
27.	1471-	-		11/06/73											
28.	1489-18152	F		11/24/73			3727N	12151W	153.0	27.0					
29.	1507-	-		12/12/73	Rain										
30.	1525-	F		12/30/73	Clear										
31.															
32.															
33.															

TABLE 02. TAPES IN STANFORD RSL DATA FILE

STANFORD

1003-18175	07/26/72
(+1003-18175 RBV)	
1075-18173	10/06/72
1183-18175	01/22/73
1255-18183	04/04/73
1273-18183	04/22/73
1291-18182	05/10/73
1345-18174	07/03/73

MONO LAKE

1055-18055	9/16/72
1091-18062	10/22/72
1063-18063	1/02/73
1235-18070	3/15/73
1307-18064	5/26/73
1397-18053	8/24/73

WALKER LAKE

1055-18053	09/16/72
1091-18055	10/22/72
1163-18060	01/02/73
1235-18064	03/15/73
1289-18063	05/08/73
1307-18062	05/26/73
1361-18054	07/19/73
1397-18051	08/24/73

SAN LUIS

1074-18114	10/05/72
1254-18125	4/03/73

S. SALINAS

1290-18130	5/09/73

BERRYESSA

1075-18170	10/06/72

NDPF USE ONLY

D
N
ID
AA
TM

TAPES
DATA REQUEST FORM -L

1. DATE 14 January 1974

2. USER ID UN 142

4. SHIP TO: R.J.P. Lyon
ADDRESS School of Earth Sciences NEW
Stanford University
Stanford, California 94305

5. TELEPHONE NO. (415) 321-2300 ext 4147/2747 NEW

6. CATALOGUES DESIRED

STANDARD U.S. NON-U.S.
DCS
MICROFILM U.S. NON-U.S.

APPROVAL TECHNICAL MONITOR

ADDDHHMMS OBSERVATION IDENTIFIER	C CENTER POINT COORDINATES	B SENSOR BAND	P PRODUCT TYPE	F PRODUCT FORMAT	T TICK MARKS	NN NUMBER OF COPIES	A AREA
	STANFORD						
1381-18172	3721N/12203W	4-7	D	9		1	U
1489-18152	3727N/12151W	4-7	D	9		1	U
	MONO LAKE						
1415-18051	3726N/11905W	4-7	D	9		1	U
	KETTLEMAN						
1452-18102	3605N/12050W	4-7	D	9		1	U
	BERRYESSA-W. SIERRA						
1363-18171	3850N/12134W	4-7	D	9		1	U
	TAHOE						
1380-18111	3850N/12007W	4-7	D	9		1	U
	FRESNO /SAN LUIS						
1380-18113	3725N/12035W	4-7	D	9		1	U